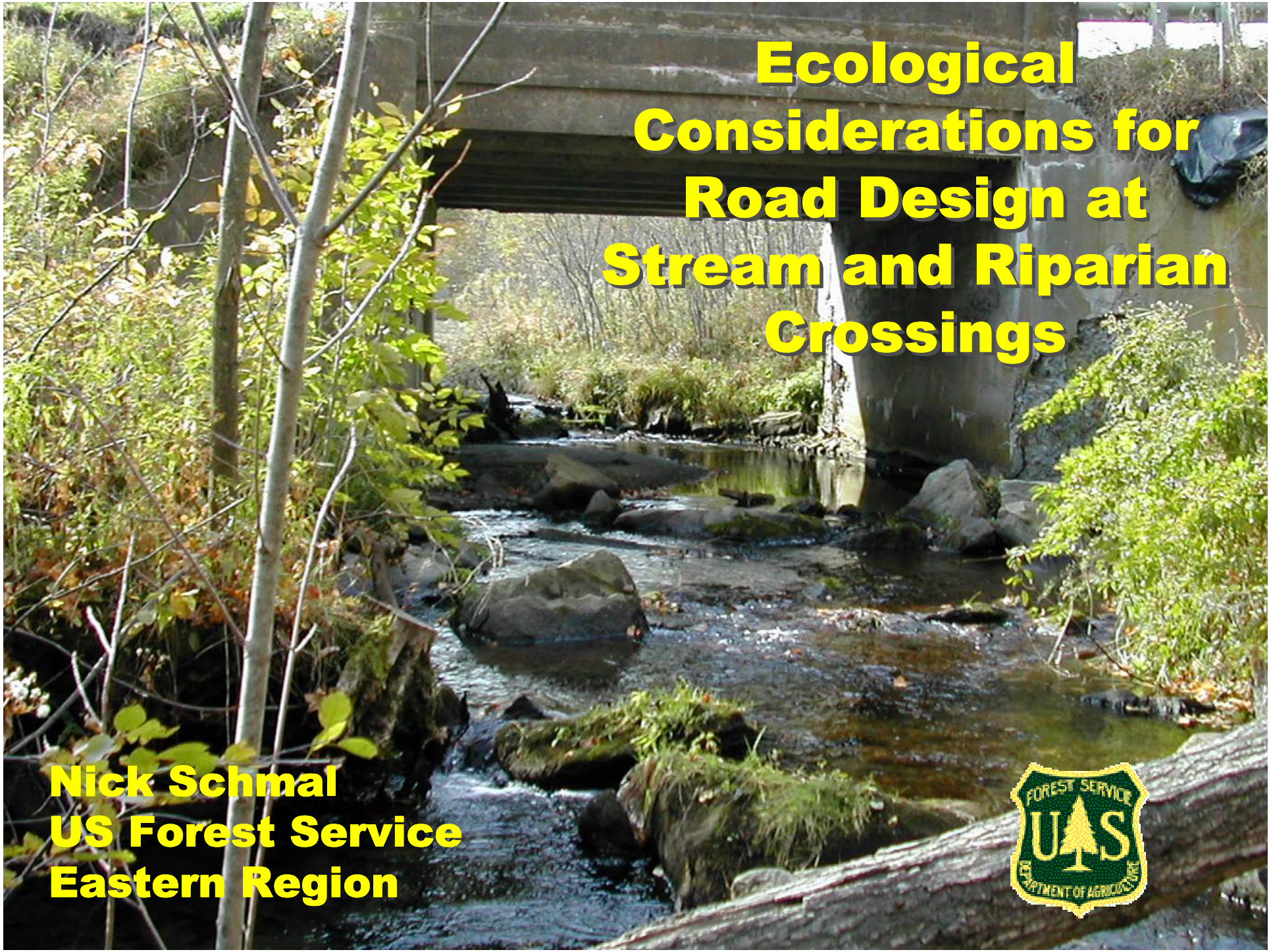
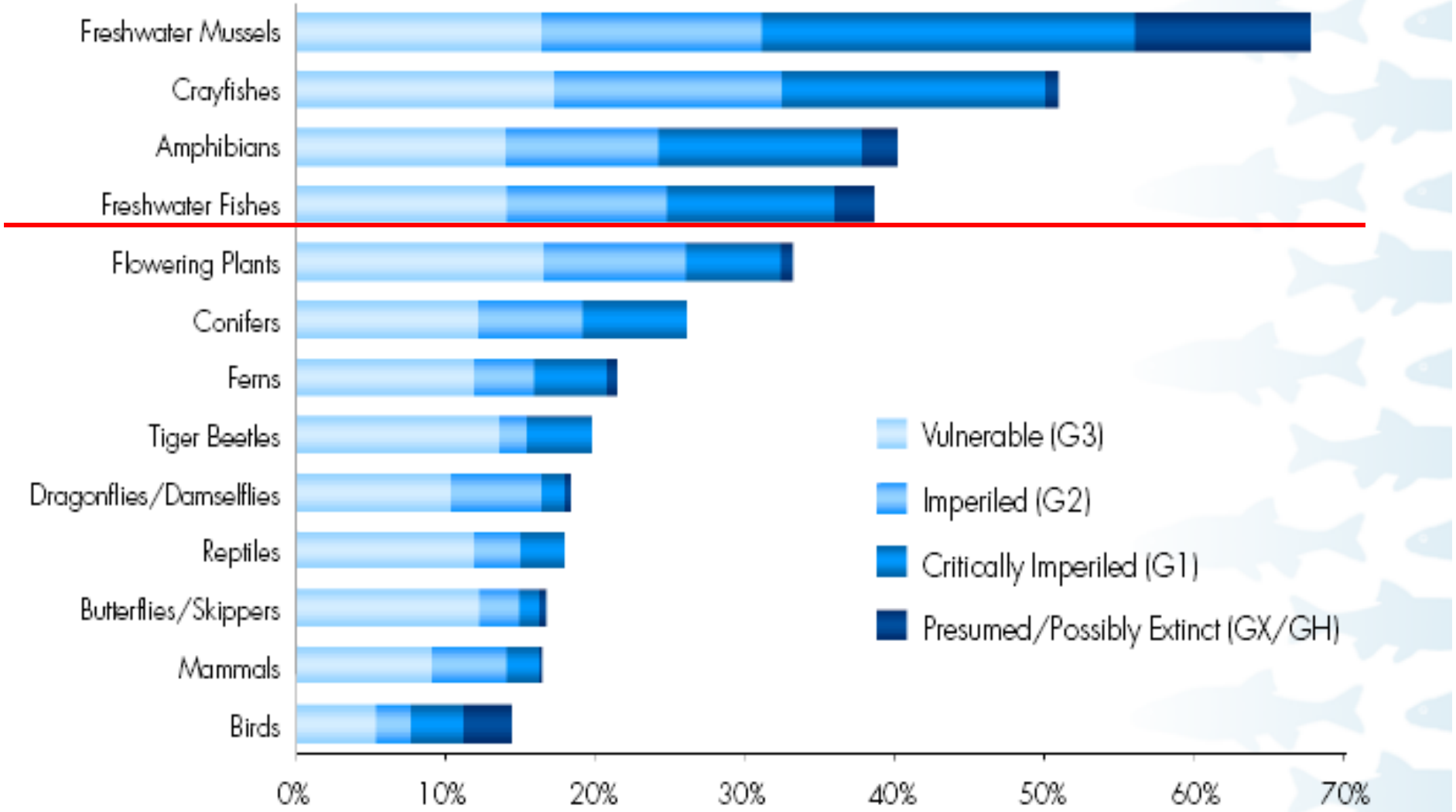


Ecological Considerations for Road Design at Stream and Riparian Crossings

Nick Schmal
US Forest Service
Eastern Region

Figure 1. Proportion of U.S. Species at Risk

The species groups that are proportionately the most imperiled—mussels, crayfishes, and amphibians—consist entirely or primarily of freshwater species. (Source: 1997 Species Report Card[21])

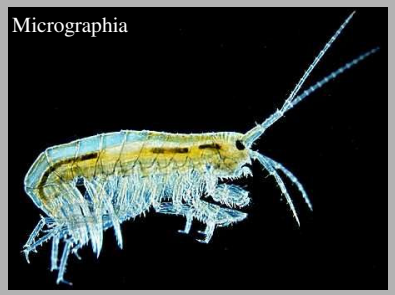


The Global Significance of Freshwater Species in the United States

From *Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity*, Masters and others. 1998. The Nature Conservancy, Arlington, Virginia.

Taxonomic Group	Described Species in U.S.	Described Species Worldwide	% of known spp. found in U.S.	U.S. Ranking Worldwide in spp Diversity
Fishes	801	8,400	10	7
Crayfishes	322	525	61	1
Freshwater Mussels	300	1,000	30	1
Freshwater snails	600	4,000	15	1
Stoneflies	600	1,550	40	1
Mayflies	590	2,000	30	1
Caddisflies	1,400	10,564	13	1
Dragonflies & Damselflies	452	5,756	8	Uncertain
Stygobites	327	2,000	16	1

Aquatic Organism Passage not just for Salmon at Road - Stream Crossings


Micrographia


Scott Jackson


Scott Jackson


Radu Cuiasu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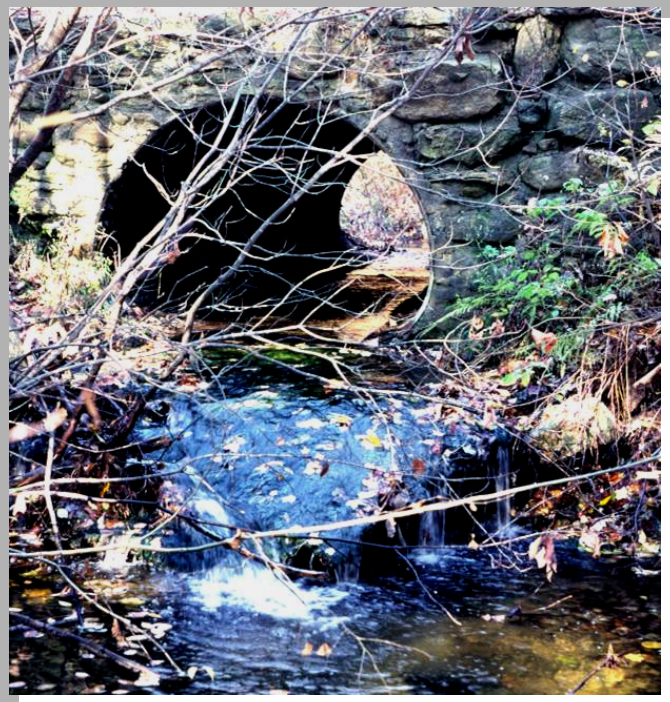
Dams

Sub-standard Culverts



Fragmentation of River, Stream and Lake/Reservoir Ecosystems

Ties directly to key infrastructure issues:

- **Abandoned and unsafe dams**
- **Poorly designed roads and trails**

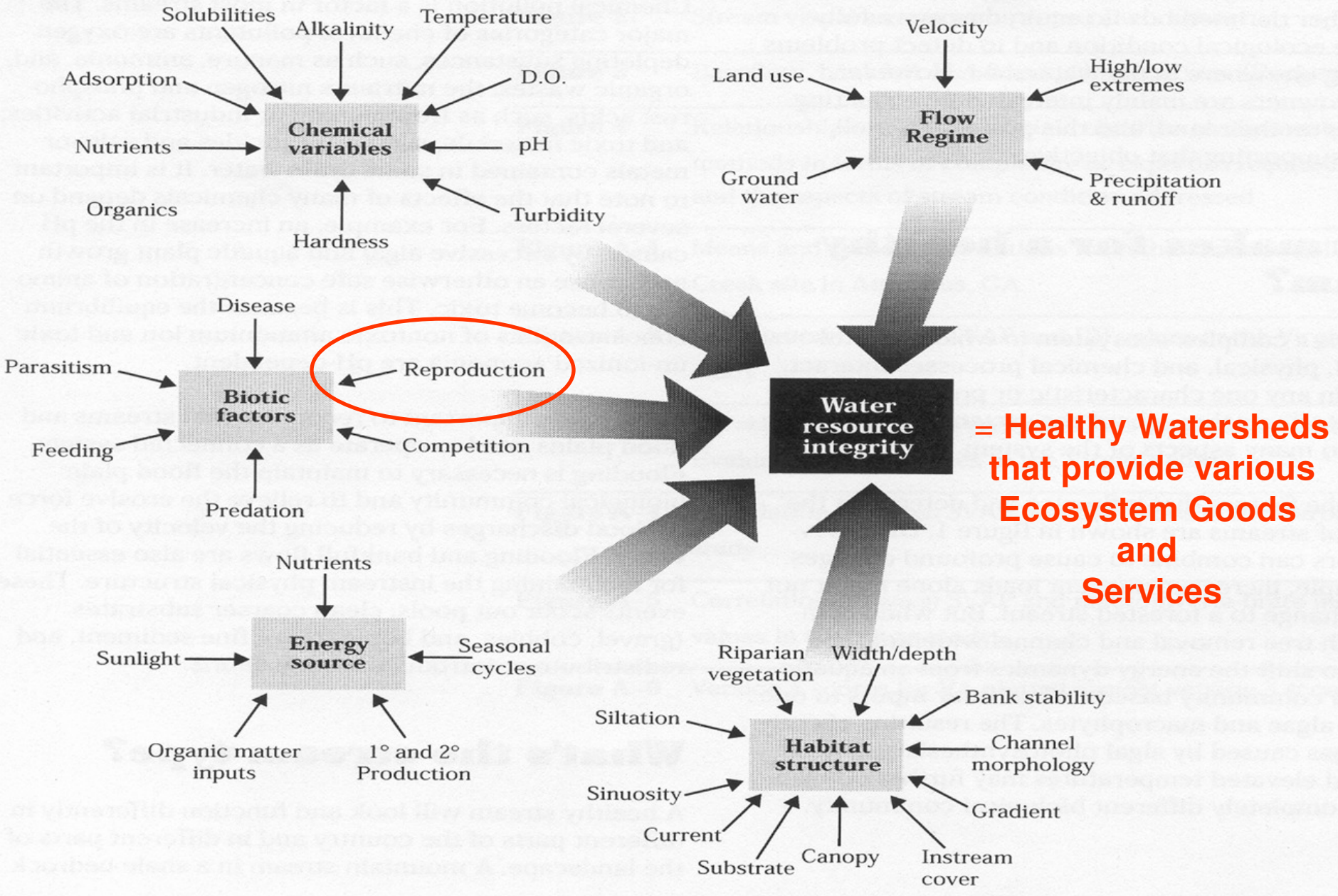
Direct implications for

- **Population structure and persistence**
- **Ecosystem structure and function**

Culvert Problems

- Inlet or Outlet drop
- Physical barriers
- Woody debris accumulation
- Excessive velocities
- Insufficient water depth
- Flow contraction (turbulence)
- Absence of bank edge areas
- Discontinuity of channel substrate
- Behavioral barriers
- Riparian fragmentation

Biological alteration of aquatic community from passage barriers



Predictive Models

Model A: Salmonidae

Salmon and Trout

Model B: Cyprinidae

Minnow Species

Model C: Percidae and Cottidae

Darters and Sculpin

Courtesy – Seth Coffman

Interdependencies

The occurrence of some species is dependent on the present of others. For example many freshwater mussel species are dependent on specific fish hosts to complete their lifecycles.

Importance of Movement

- Daily movements
- Changes in habitat conditions
- Reproduction
- Exploit vacant habitat
- Population continuity
- Dispersal

Impacts of Stream and Riparian Crossings

- Habitat loss and degradation
- Roadkill leading to loss of populations
- Alteration of Ecological Processes
- Reduced access to vital habitats
- Population fragmentation & isolation
- Disruption of processes that maintain regional populations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Reduced Access to Vital Habitats

- Spawning habitat
- Nursery habitat
- Foraging areas
- Deep water refuges
- Seasonal habitats


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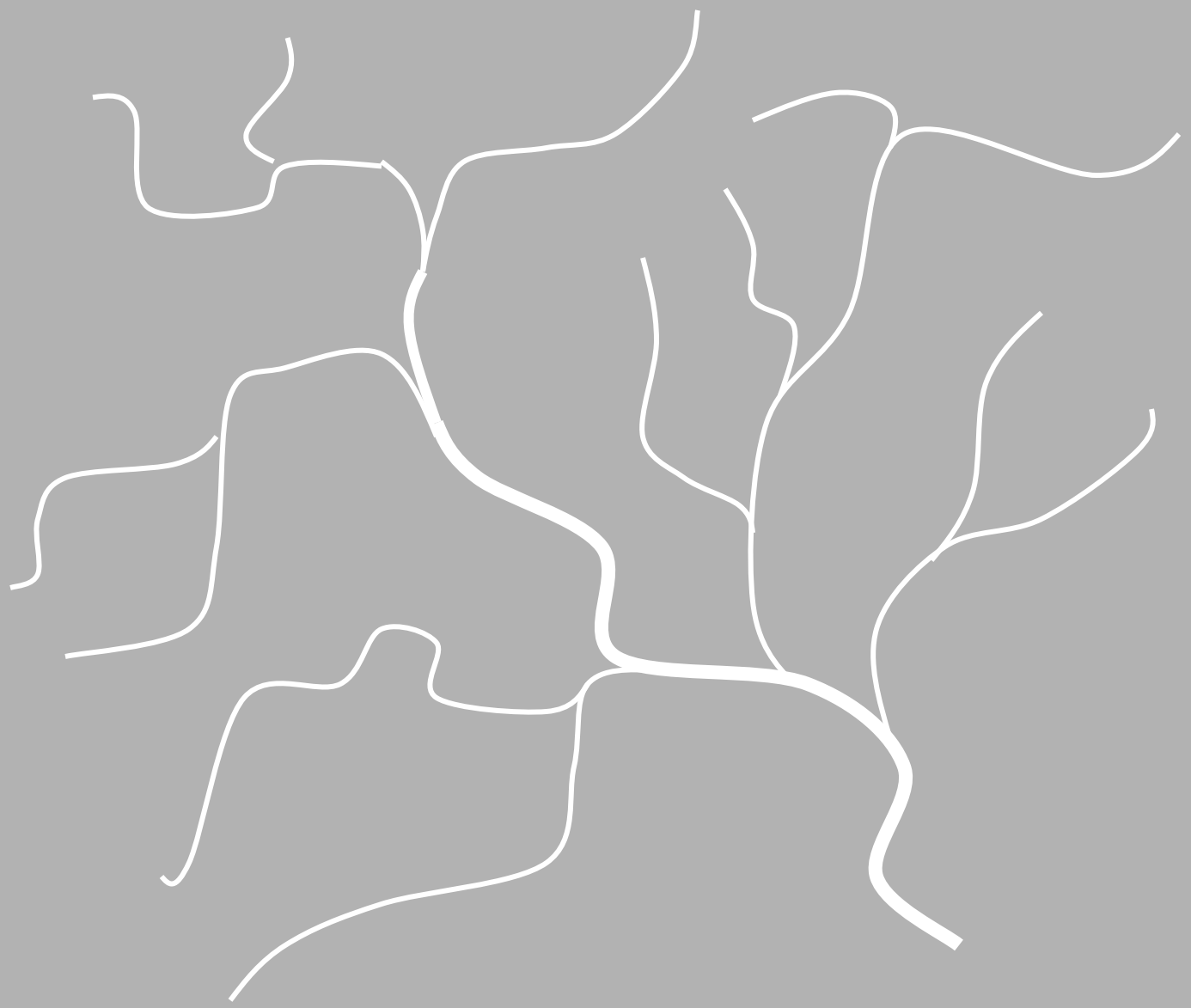
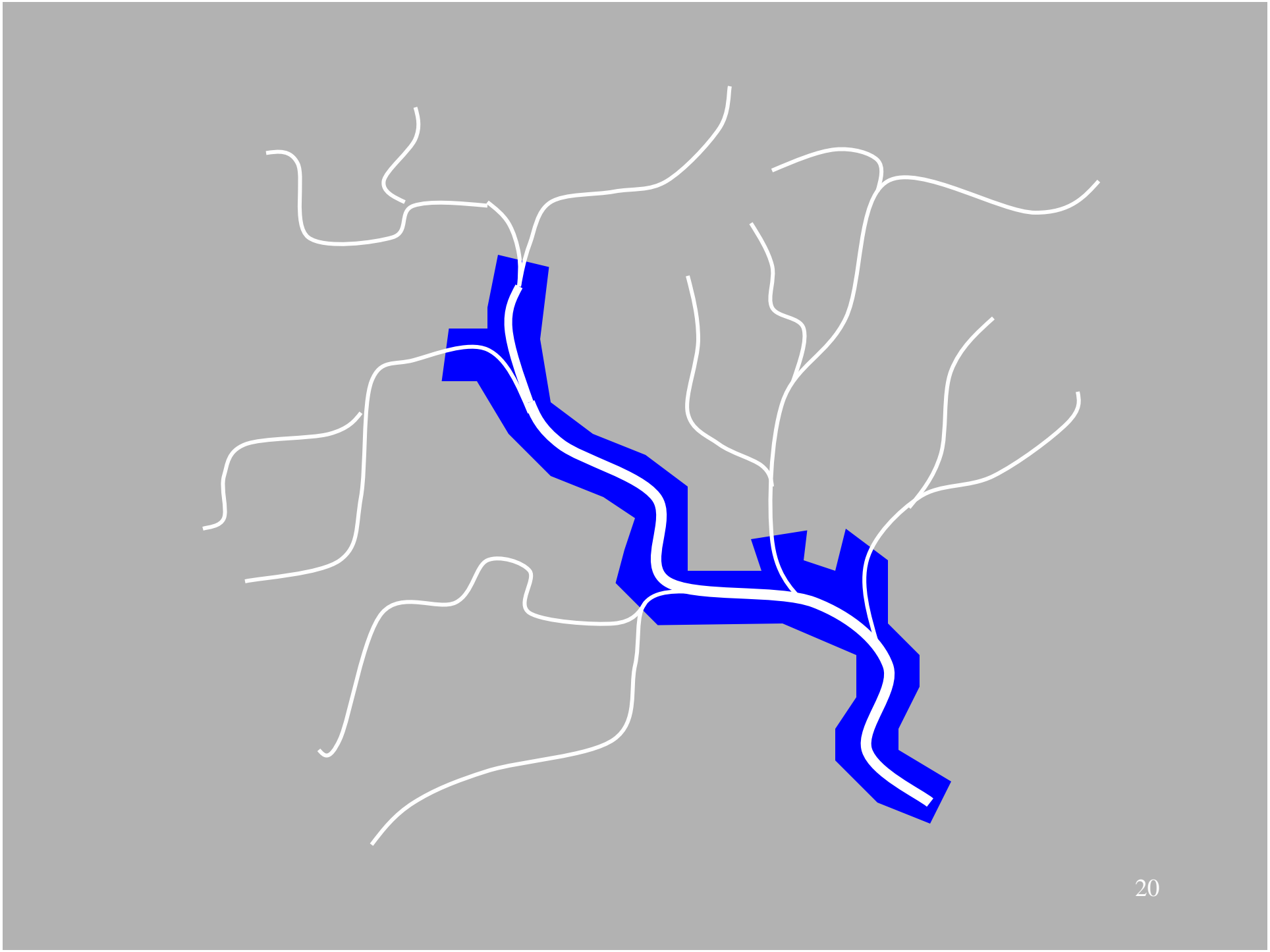
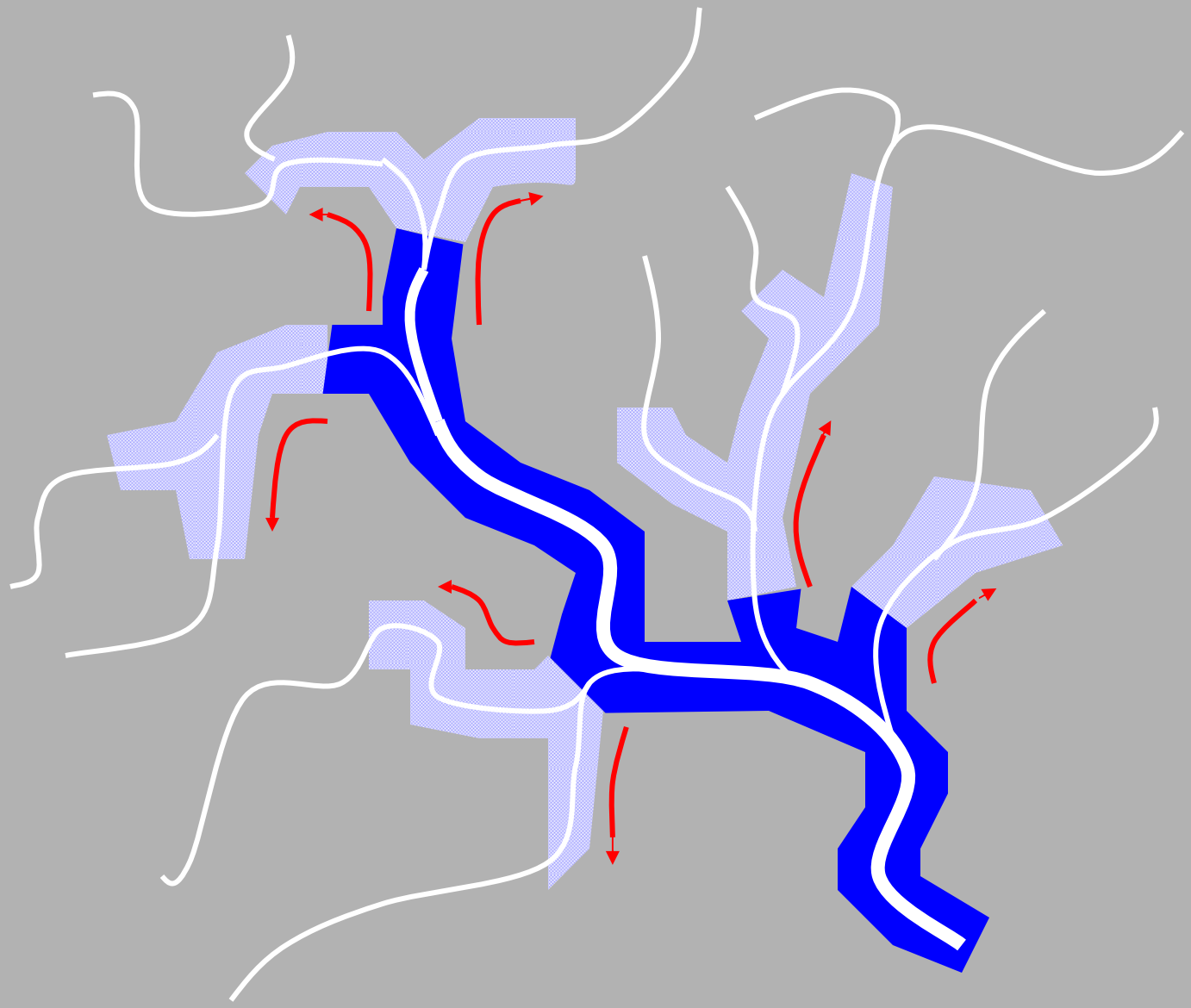
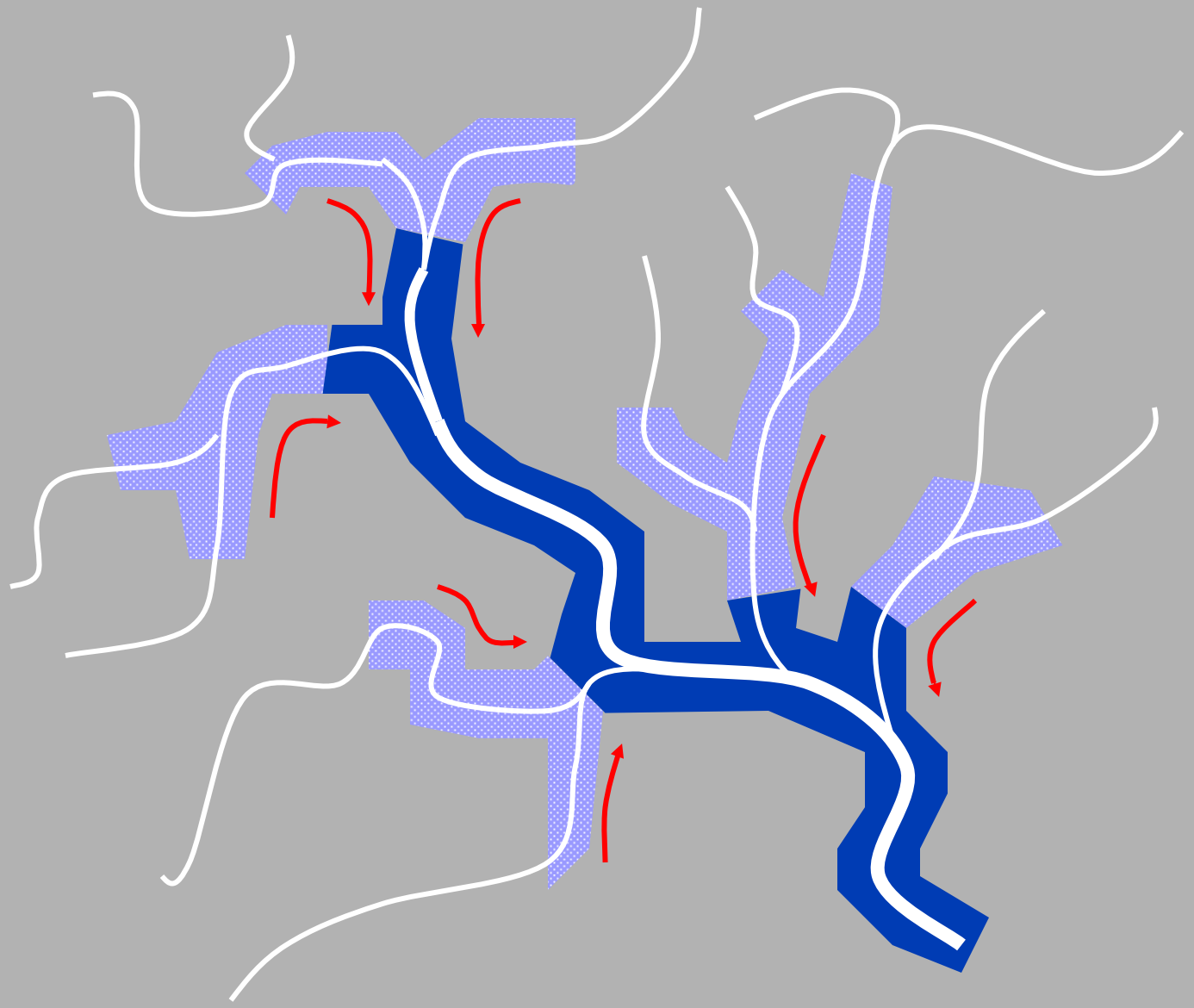
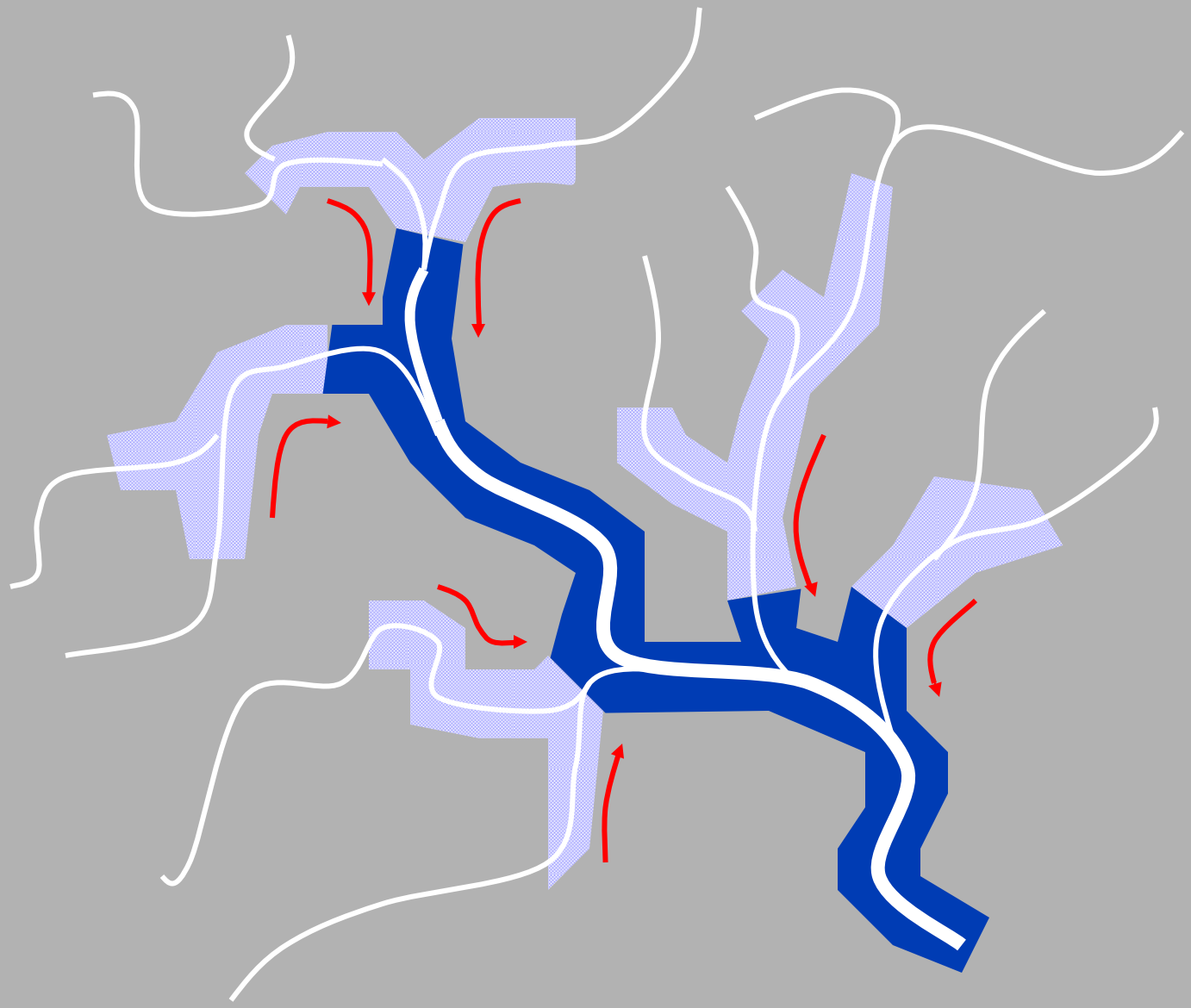
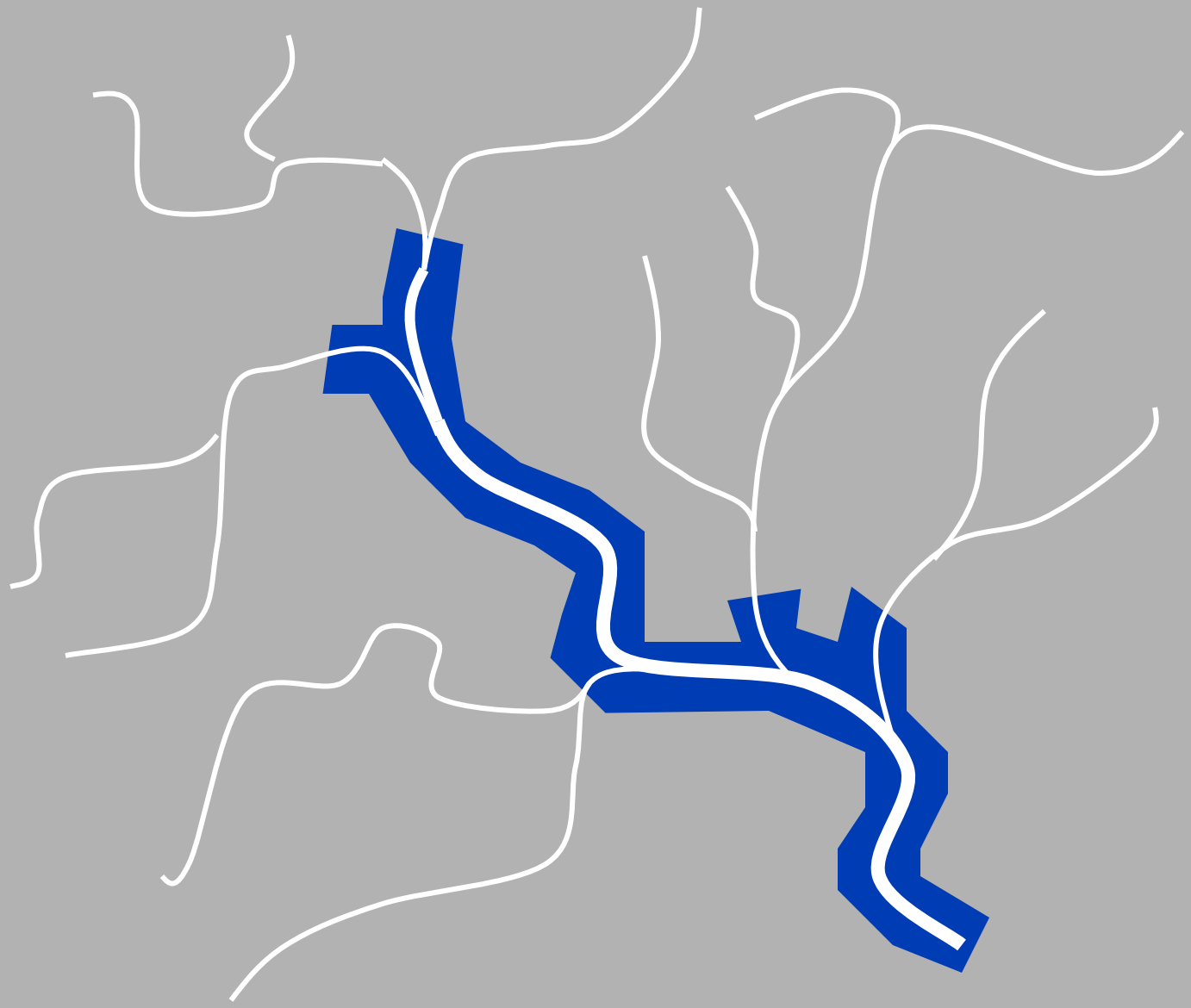


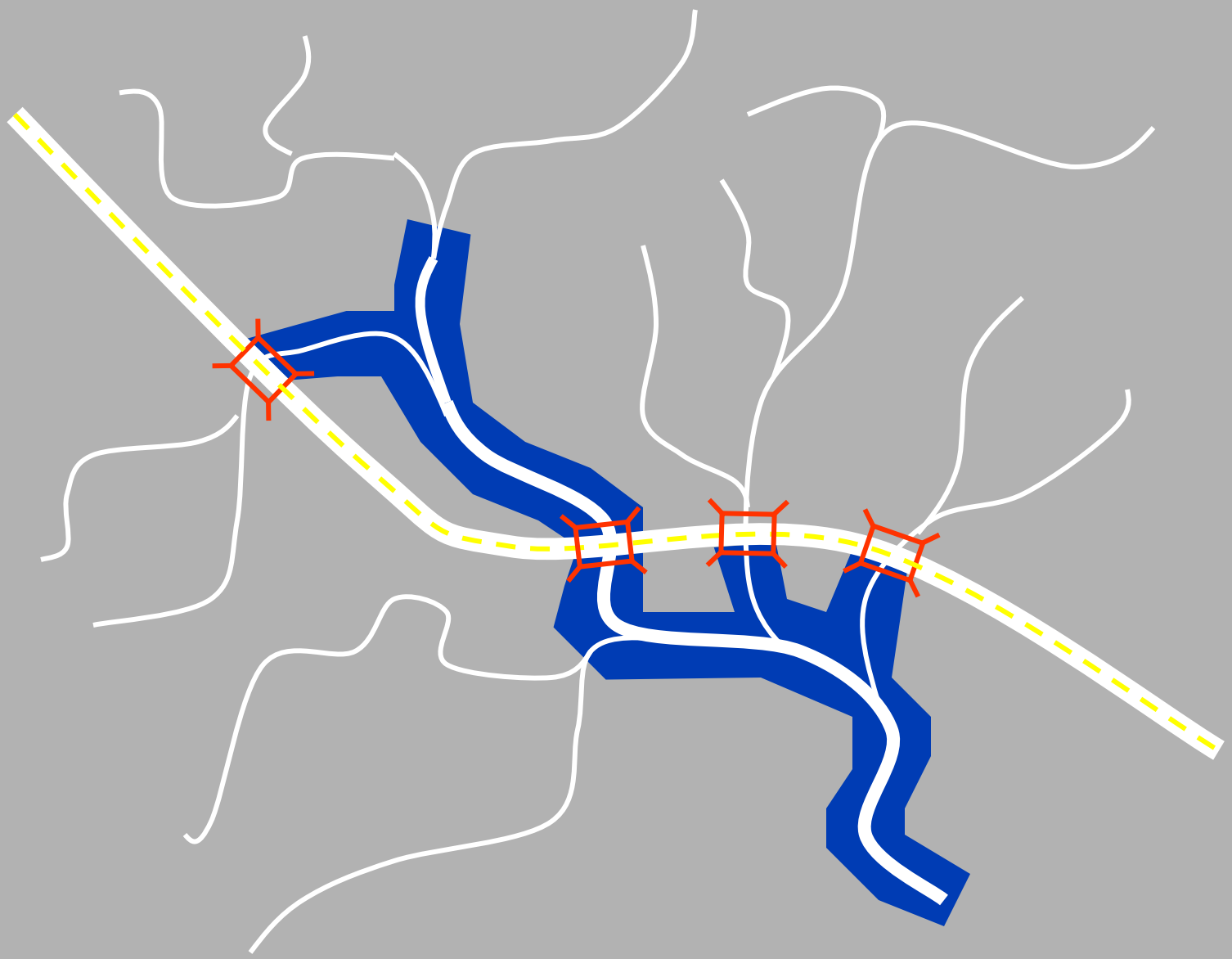


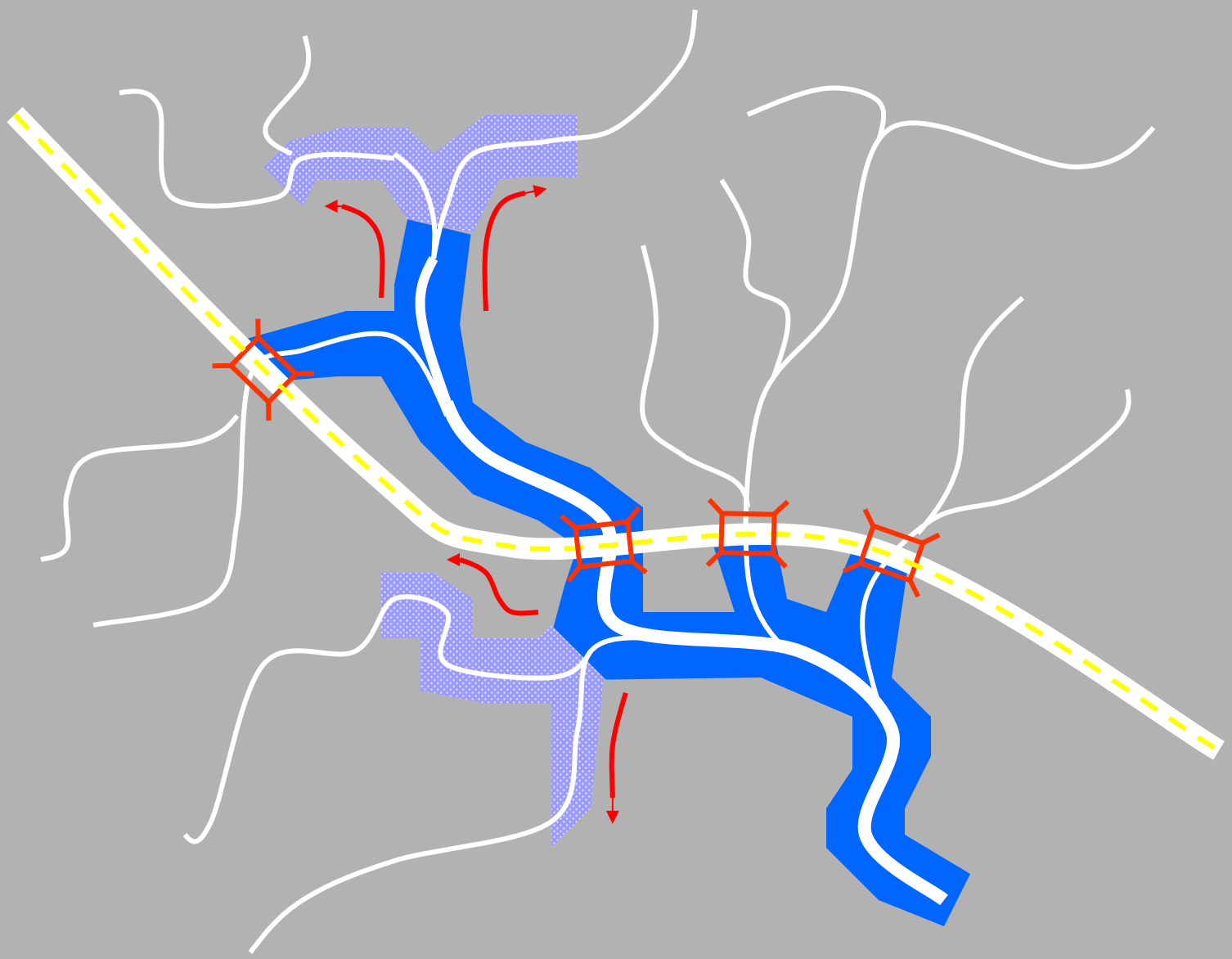


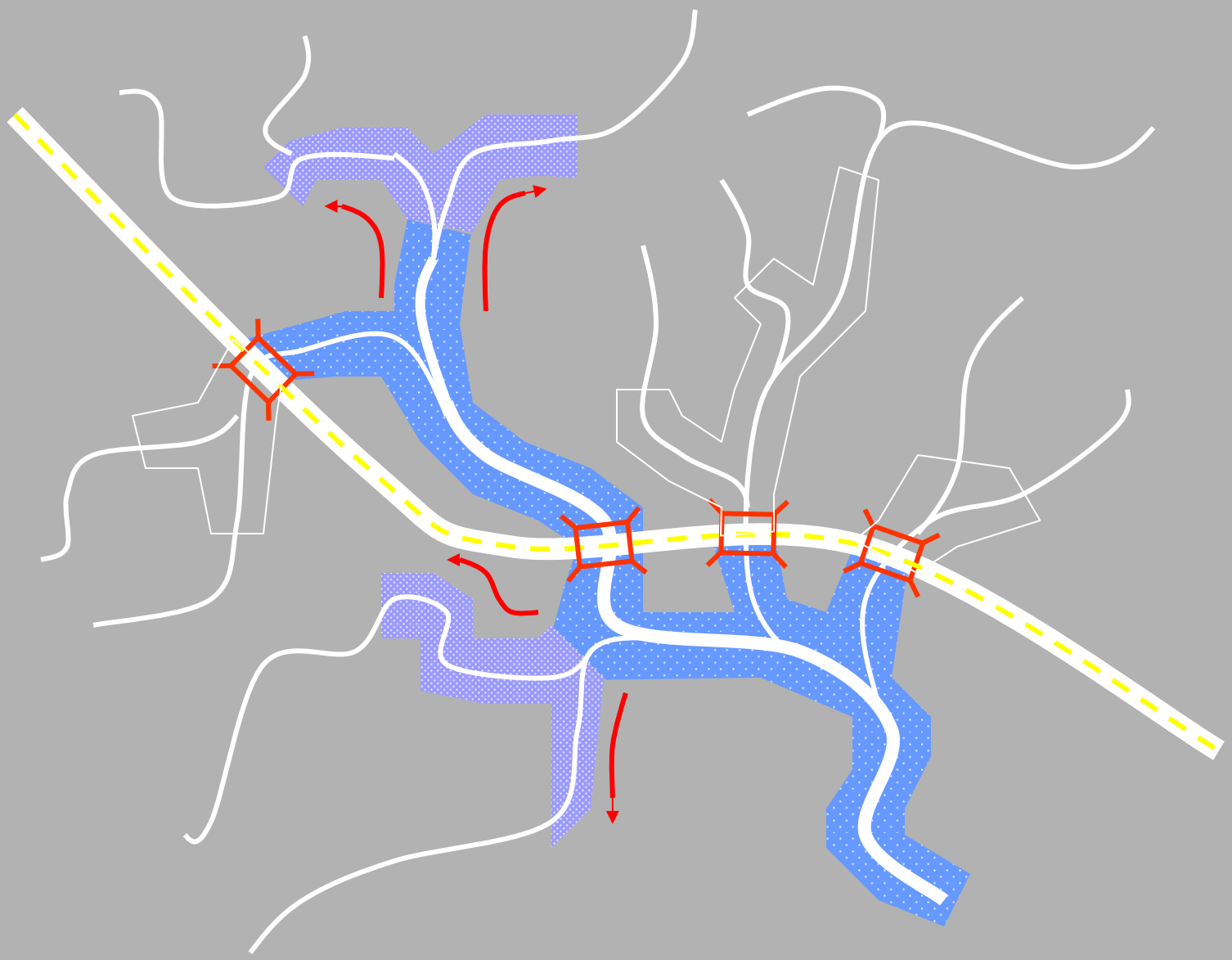












Population Fragmentation and Isolation

- Barriers to movement subdivide or isolate populations
- Smaller and more isolated populations are more vulnerable to:
  - extinction due to chance events
  - genetic changes

Mudpuppy

Amphiuma

Hellbender

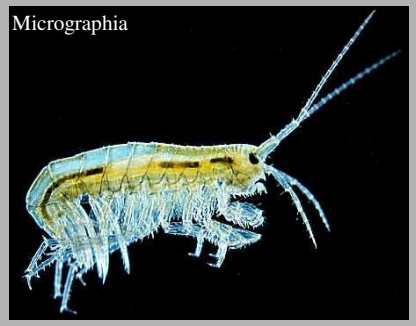
Cope's Giant Salamander

Softshell turtles

Musk turtles

Isopods

Crayfish



Amphipods

Worms

Mussels

Importance of Small Streams

- Make up a large percentage of stream miles
- Cumulatively provide more habitat than large rivers
- Support species not found in larger streams and rivers
- Provide important spawning & nursery habitat for fish


Wood turtle
Scott Jackson


Beaver


Muskrat
© 2003 John White


Scott Jackson
Snapping turtle


Star-nosed mole
Kenneth Catania


Otter


©1996 Brad Moon
Idaho Giant Salamander

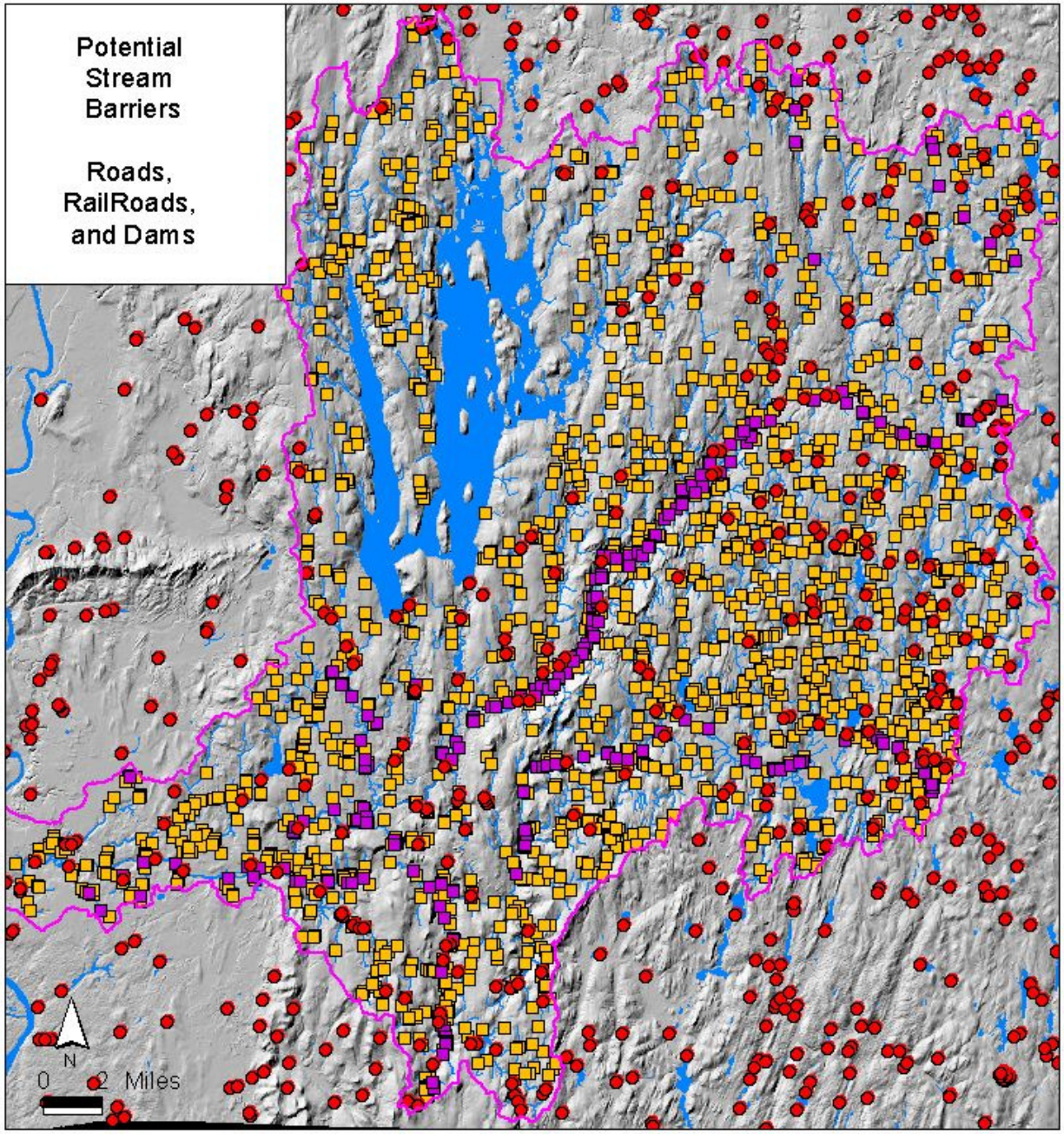

Suzanne Collins


Scott Jackson
Dusky salamander


Mink

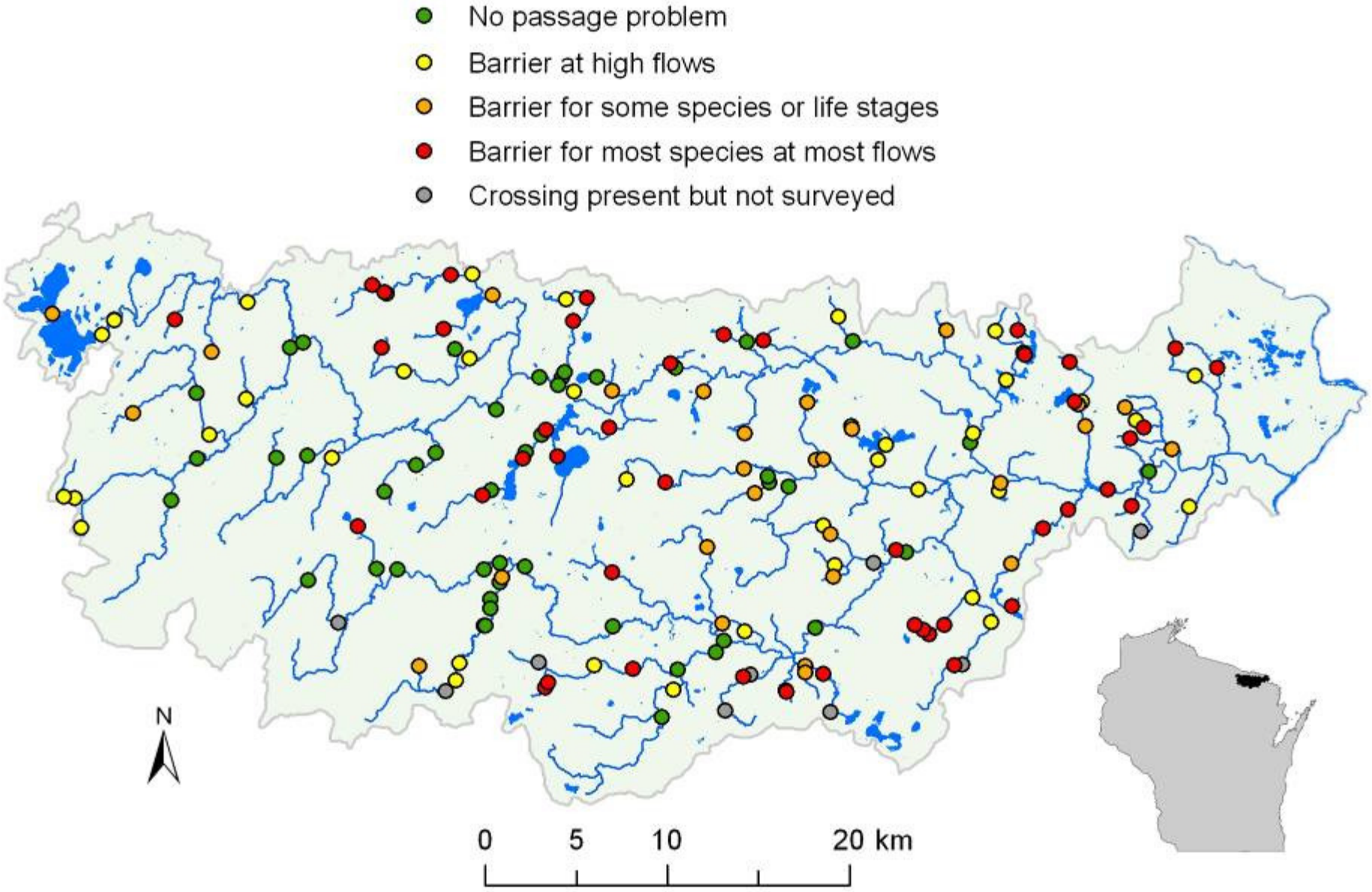
Expanded Bridges Provide “openness”

CHICOPEE WATERSHED

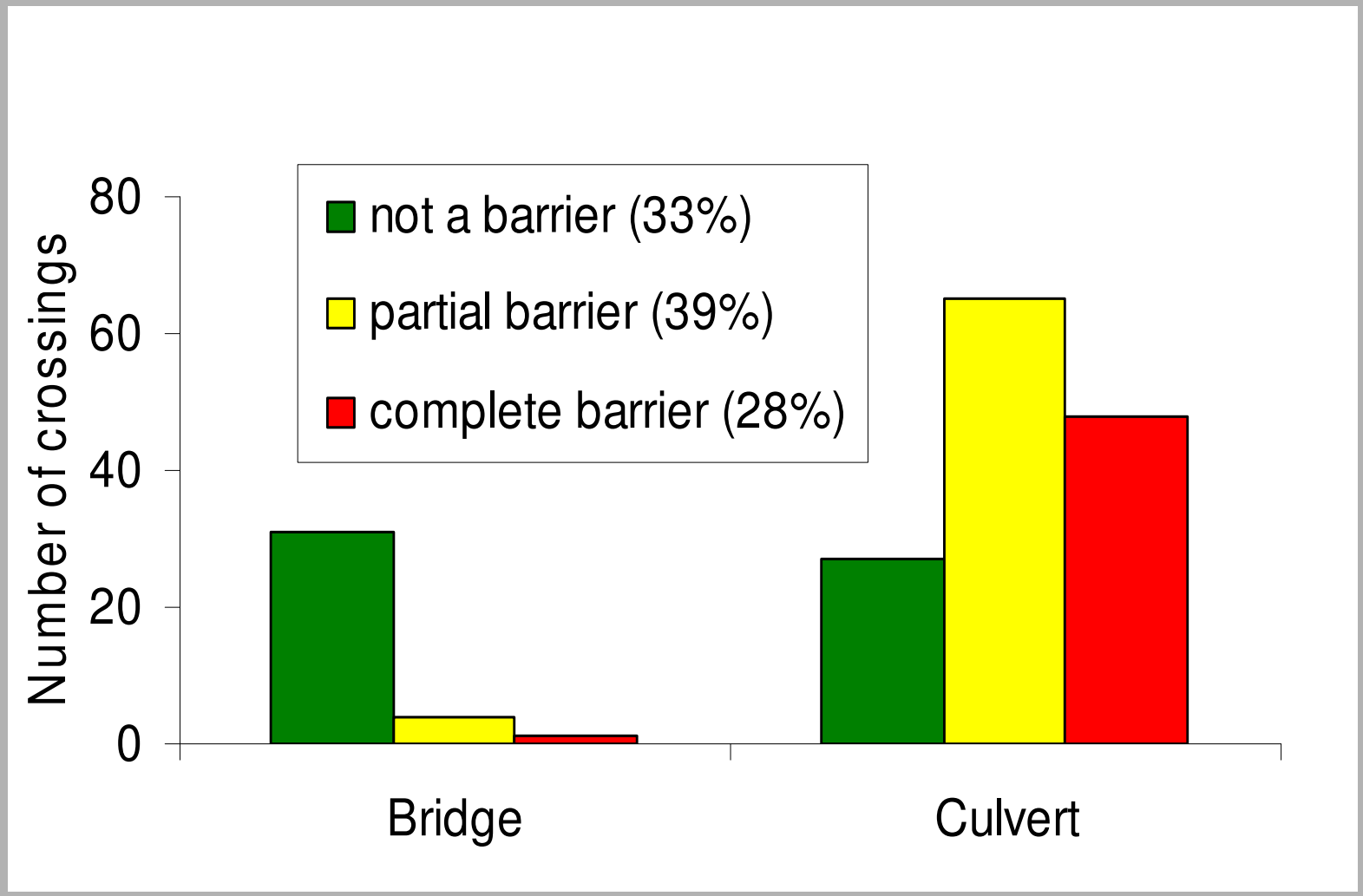


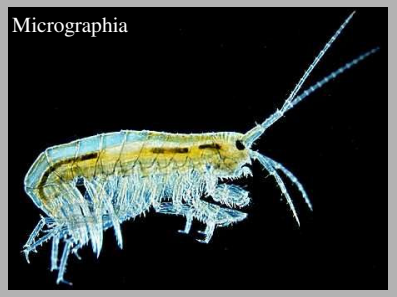
Source:
MA Riverways Program

Road Crossings in the Pine-Popple Watershed



What kind of crossings are barriers?

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Kenneth Catania

Aldo Leopold, 1953:

"If the biota, in the course of eons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering."